An Analysis of Faunal Remains From A Denbigh Flint Complex Camp at Matcharak Lake, Alaska

Andrew H. Tremayne

Abstract. The Matcharak Lake site, located in the Brooks Range, Alaska, represents the first faunal assemblage recovered from a Denbigh Flint Complex (early Arctic Small Tool tradition) locality anywhere in Arctic Alaska. Organic remains, which include numerous bone tools, are well preserved in the frozen tundra soil of this 3,900 year-old site. Over 81,000 faunal specimens were unearthed with the identified portion predominantly composed of caribou; however, Dall's sheep, small mammals, bird, and fish were also recovered. Seasonal indicators suggest the hunting and butchering events occurred in the fall and spring. The presence of migratory bird and Alaska marmot suggest people camped here in the summer as well. Empirical evidence for Paleoeskimo subsistence are limited to coastal sites in the eastern Arctic. Matcharak Lake provides the first substantial dataset for supporting subsistence models for inland Denbigh groups in Alaska. Caribou clearly dominate in terms of potential calories and resource materials for clothing and shelter.

Introduction

The Denbigh Flint complex is the earliest northern Alaskan manifestation of the widely distributed Arctic Small Tool tradition (ASTt), which occurs in varying phases from the Aleutian Islands along the Bering Sea and Arctic Ocean coasts to the interior Brooks Range, Arctic Canada, and Greenland (Davis and Knecht 2005; Dumond and Bland 1993; Giddings 1964; Irving 1953; Knuth 1954; Meldgaard 1952). Denbigh sites range in age from 4500 to 2000 years B.P. (Slaughter 2005). Most researchers agree the Denbigh Flint complex originated in the Siberian Neolithic, as represented by the Syalakh and Bel'kachinsk cultures found in the Aldan and Lena River regions of Siberia about 5200–6200 years B.P. (Ackerman 1998; Anderson 1984; Dumond and Bland 1993; Hoffecker 2005; Mochanov 1969; Powers and Jordan 1990). Some debate persists as to whether its final evolution, i.e., Denbigh, took place in Arctic North America or Siberia (Dumond 1984:75; Maxwell 1980:166).

Previously proposed models of seasonal subsistence strategies for Denbigh Flint Complex people revolve around a diet of caribou, seals, and anadromous fish (Ackerman 1998; Anderson 1970; Dumond 1987; Giddings 1964). The models are based on site location, tool typology, analogy to later archaeological manifestations, and ethnographic examples (Giddings 1964), and on small, fragmentary faunal assemblages (Anderson 1988; Giddings 1964, Irving 1964; Larsen 1968)—the sum total of which would not fill a small coffee can. The underlying ecological argument of these models is that limited resources in the Arctic permit limited prey options.

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A dearth of Denbigh sites with preserved organic remains and faunal material has precluded empirical testing of the proposed model. This lack of faunal remains hampers our ability to accurately reconstruct seasonal mobility patterns and diet, and to track temporal and spatial variation in technology, as it relates to the Denbigh subsistence organization (Odess 2003; 2005). It is clear that caribou have been an important human resource in the Arctic (e.g., Morrison 1997; Spiess 1979), but some uncertainty exists as to how specialized Denbigh hunters were, and to what degree they relied on maritime and riverine resources. The role of small mammals, birds, and non-migratory fish is also seldom addressed, even though they likely served as a significant supplementary resource. The Denbigh subsistence model has been limited by available data and is thus too generalized and lacking in corroborative evidence or specific zooarchaeological analogs.

Up until now, Arctic Small Tool (ASTt) tradition sites with well-preserved organic remains were restricted to the eastern Arctic of Greenland and Canada. These sites provide evidence to support the hypothesis that ASTt people exploited a variety of large and small terrestrial and maritime resources (e.g., Darwent 2004, in press; Meldgaard 2004). In Greenland, early ASTt (locally referred to as Saqqaq) subsistence information paints a picture that is much more complex than models predict for the Alaska Denbigh, yet most researchers agree that ASTt originated in the west (e.g., Dumond 1987; Maxwell 1980, 1985; McGhee 1996; Rasmussen et al. 2010). Faunal assemblages from early ASTt across the eastern Arctic exhibit marked regional variation from caribou or muskox exploitation to a focus on seals or birds. The frozen Saqqaq site of Qeqertasussuk, for example, contains an unprecedented assortment of faunal remains including domestic dog, caribou, walrus, five species of seal, six species of whale, eighteen different species of birds, and a variety of fish and shellfish, which clearly underscores the occupants' adaptation to a broad array of resources shortly after arrival in West Greenland (Meldgaard 2004). This impressive list of prey, along with harpoons and the earliest evidence for boats, demonstrates that early ASTt people were sophisticated hunters with innovative technologies, of which most were fashioned out of organic materials absent from the archaeological record in Alaska. Were these complex technologies and adaptive strategies carried to Greenland from Alaska or were they developed along the way? In order to answer this question and to examine early ASTt within a broader temporal and spatial context, archaeologists need to identify and excavate Alaskan sites with well-preserved organic material. This paper presents the results from the analysis of the first Denbigh Flint complex site in northern Alaska to yield a substantial faunal assemblage. The data generated by the analysis are used to further our understanding of Denbigh seasonal mobility, use of the interior, diet breadth, and subsistence strategies in an environment where migrating caribou transform a desolate landscape to a land of plenty a few months out of every year.

Matcharak Lake Site

This study is concerned with the composition of faunal remains recovered from site AMR-186 situated on the shores of Matcharak Lake, located in western Gates of the Arctic National Park, Alaska (Fig. 1). AMR-186, located on an elevated 15 meter high glacially deposited terrace, was discovered in 2007 and was test excavated in 2008 and 2009 by National Park Service archaeologists (Tremayne 2010a). The primary goals of the excavations were to determine the nature of the deposit, cultural affiliations, age of the occupation, and the physical extent of the site. We soon determined that the Matcharak Lake site contained an ASTt component and a large number of associated faunal remains preserved in a frozen matrix of peaty loam. A total of 22 1 × 1 m. test units were excavated across the flat, willow-covered terrace (Fig. 2), revealing an estimated 2,500 stone artifacts including diagnostic Denbigh tools and over 81,600 bone fragments (Tremayne 2010a). A series of controlled probes were dug around the perimeter of the site, which defined the depositional boundaries as roughly 45 × 15 meters. Block A (3 × 5 m) and Block B (1 × 3 m), and the four slope units represent an estimated 10–12% of the area containing buried cultural deposits (Fig. 2).

The Matcharak Lake site is identified as belonging to the Denbigh Flint complex based on two main criteria: diagnostic stone tools (Fig. 3) and radiocarbon dates (Table 1). While analysis of the formed tools and lithic debitage recovered at Matcharak Lake is ongoing, a sample of several diagnostic tool types, consistent with other Denbigh sites, is provided for comparison (Anderson 1988; Giddings 1951; Irving 1964) (Fig. 3). A total of 10 bone collagen (caribou and squirrel) and charred plant (willow and birch) samples were submitted for radiocarbon dating to Beta Analytic (Table 1). With the exception of one outlier (Beta-252179 at 4020 ± 40 B.P.), nine dates range from 3680 ± 40 B.P. to 3430 ± 40 B.P., which yields a 2-sigma calibrated age of between 2190 and 1630 cal B.C. Given the tight cluster of three of these dates, with two yielding identical conventional ages, most likely this site was occupied approximately 3580 radiocarbon years ago, or 3900 calendar years ago (2030–1780 cal B.C.). While slightly younger than Onion Portage and Iyatayet, radiocarbon dates from AMR-186 are contemporaneous with Punyik

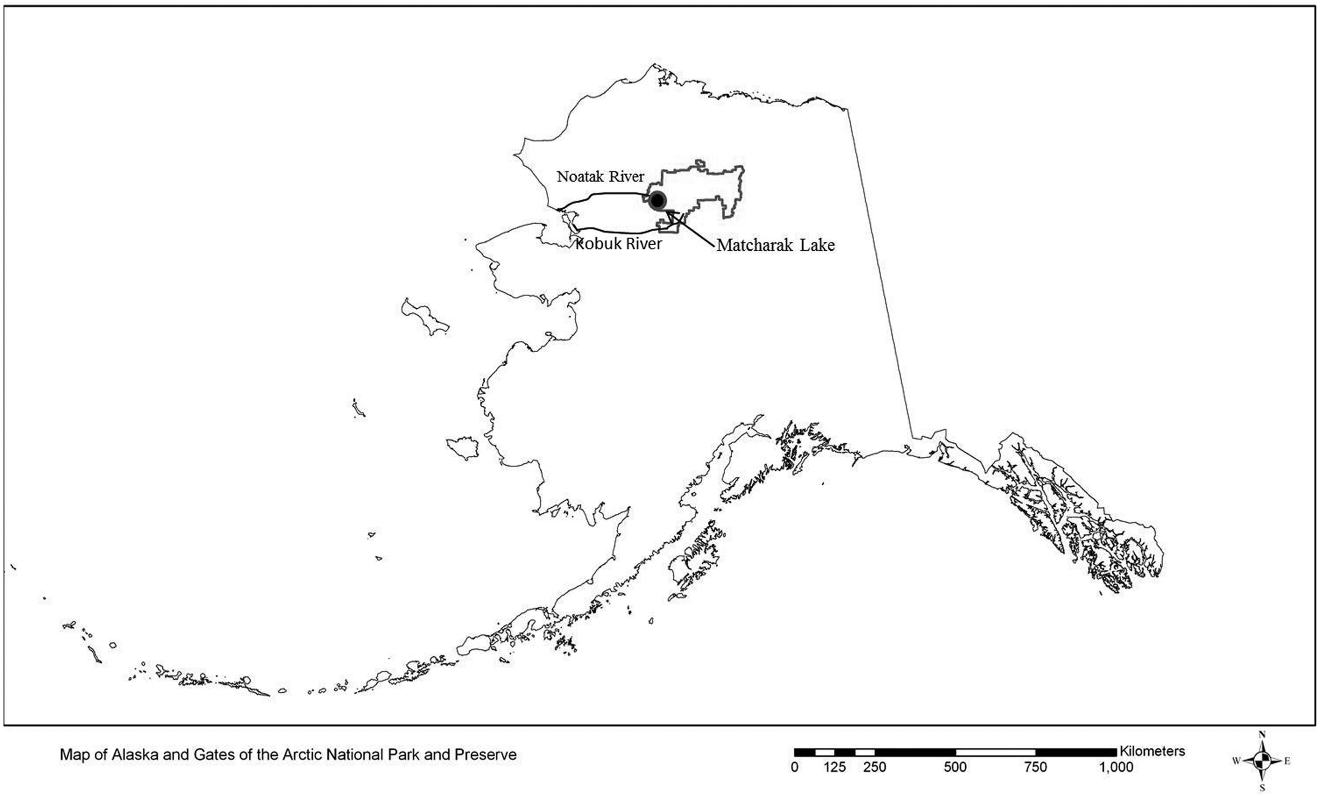

Figure 1. Map indicating the location of Matcharak Lake within Gates of the Arctic National Park and Preserve in the central Brooks Range, Alaska.

Point, Croxton, and Mosquito Lake, three well-known interior Denbigh sites (Slaughter 2005).

In addition to the large, well-preserved faunal assemblage, Matcharak Lake is significant for the recovered organic tools. Three complete bone or antler points, similar to one described by Irving (1962) were recovered. These tools may have served as composite fish hooks (see Giddings and Anderson 1986:Plate 12), barbs of a leister prong, or projectile points (Fig. 4). We recovered one modified antler interpreted to be a pressure flaker, and another which likely served as a soft hammer. A number of modified antler and bone fragments were recovered representing tool preforms and waste from the production of other tools. These artifacts are significant because they preserve the methods employed to score and cut organic material for tool construction. Most exciting was the discovery of a worked rib bone (Fig. 5), which appears to be the dorsal half of a foreshaft, and compares favorably to a number of bone arrowheads from Trail Creek Caves (Larsen 1968:Plate VI) and to a similar object from Engigstciak, a western Canadian ASTt site (MacNeish 1956:108;Plate III:29). Three precisely incised grooves carved with a burin or burin spall along the dorsal side of the tool (Tremayne 2010b) allude to an artistic or design element similar to patterns seen in contemporaneous pre-Dorset designs from sites from the Canadian north (Larsen 1968:70).

Analytical Methods

Identification of the faunal specimens was completed by comparison to skeletal reference collections at the University of Wyoming, University of Alaska's Museum of the North in Fairbanks, the Alaska Consortium of Zooarchaeology at the University of Alaska Anchorage, and the University of Washington's Department of Fisheries Science. Common name, scientific name, and taxonomy for mammals follow MacDonald and Cook (2009); fish and bird taxonomy, Latin and common names follow Pielou (1994) and Alderfer (2006).

Depending on the level of experience of the analyst, the number of fragments identified to a given taxonomic level will vary (Grayson 1984:16). Accounting for skeletal variability between individuals of a given species is difficult with a limited reference collection, i.e., most collections lack a complete array of ages and sexes for any given species of animal. Sexual dimorphism, age, and

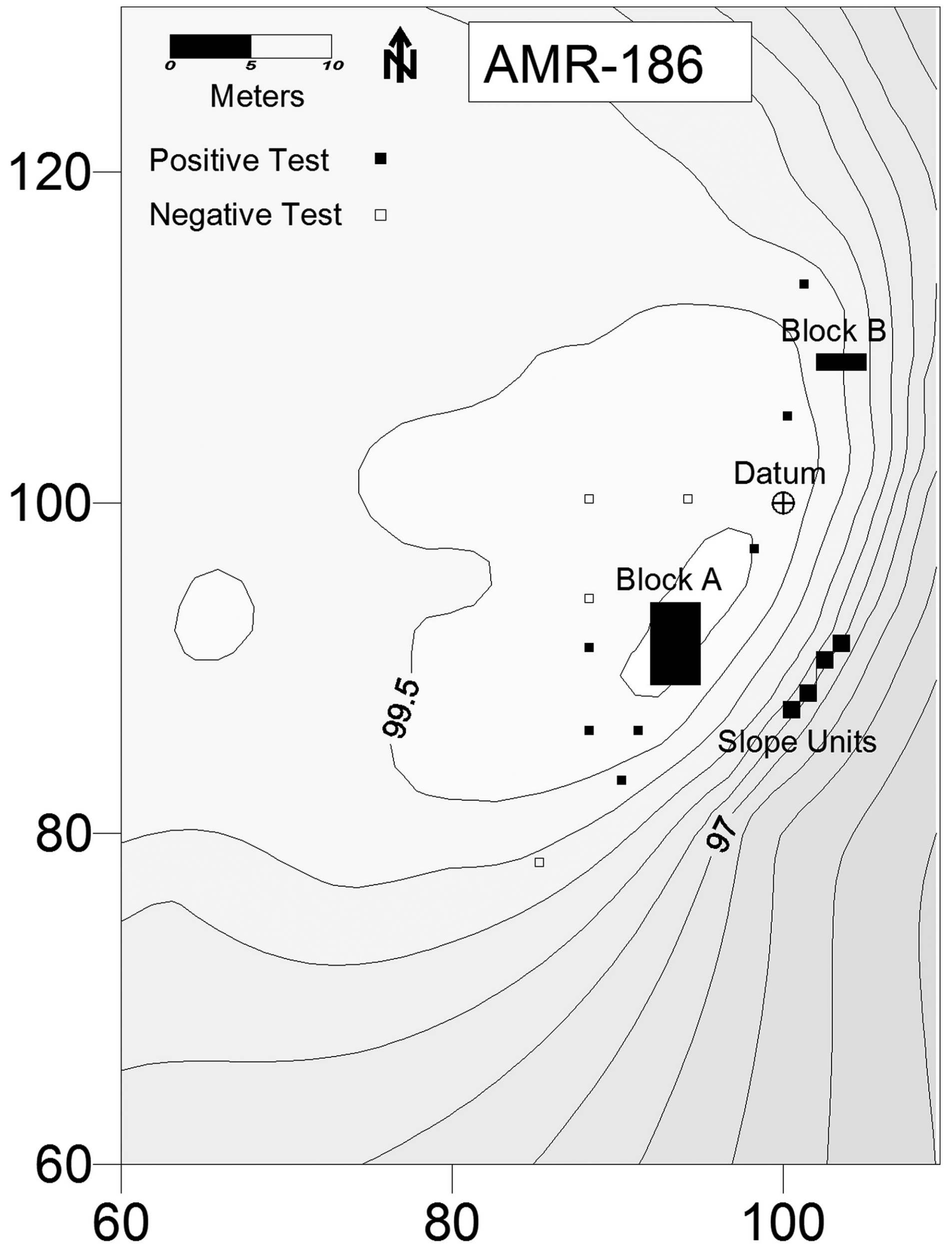

Figure 2. Map of site AMR-186 excavation and testing areas. X and Y axes represent Easting and Northing values. Contours are at 50 cm intervals.

pathological deformation can create morphological differences. Consequently, in my analysis, if positive identification was questionable, the bone fragment was recorded at a higher taxonomic level or as an unidentified fragment.

Each bone was identified as mammal, bird, or fish based on shape, size, and texture of the bone fragment. For identified specimens I recorded order, family, genus, species, element, completeness, and the portion represented (e.g., distal, proximal, anterior, posterior, medial, lateral, or a combination of these locations). A series of prominent diagnostic landmarks, such as tubercles, fossa, and nutrient foramina were used to identify the specific part of the element (see Morrison 1997:Table 3.2). Where possible, the element was sided left, right, or axial. I also recorded the type of observed breakage (Gilbert 1980; Lyman 1994). Impact scars, spiral fractures, and cut marks were recorded (Fig. 6). I noted dry fragmentation that commonly occurs with disintegrating bones and natural decomposition, though these data are not addressed in this report.

One of the goals of zooarchaeological anal-

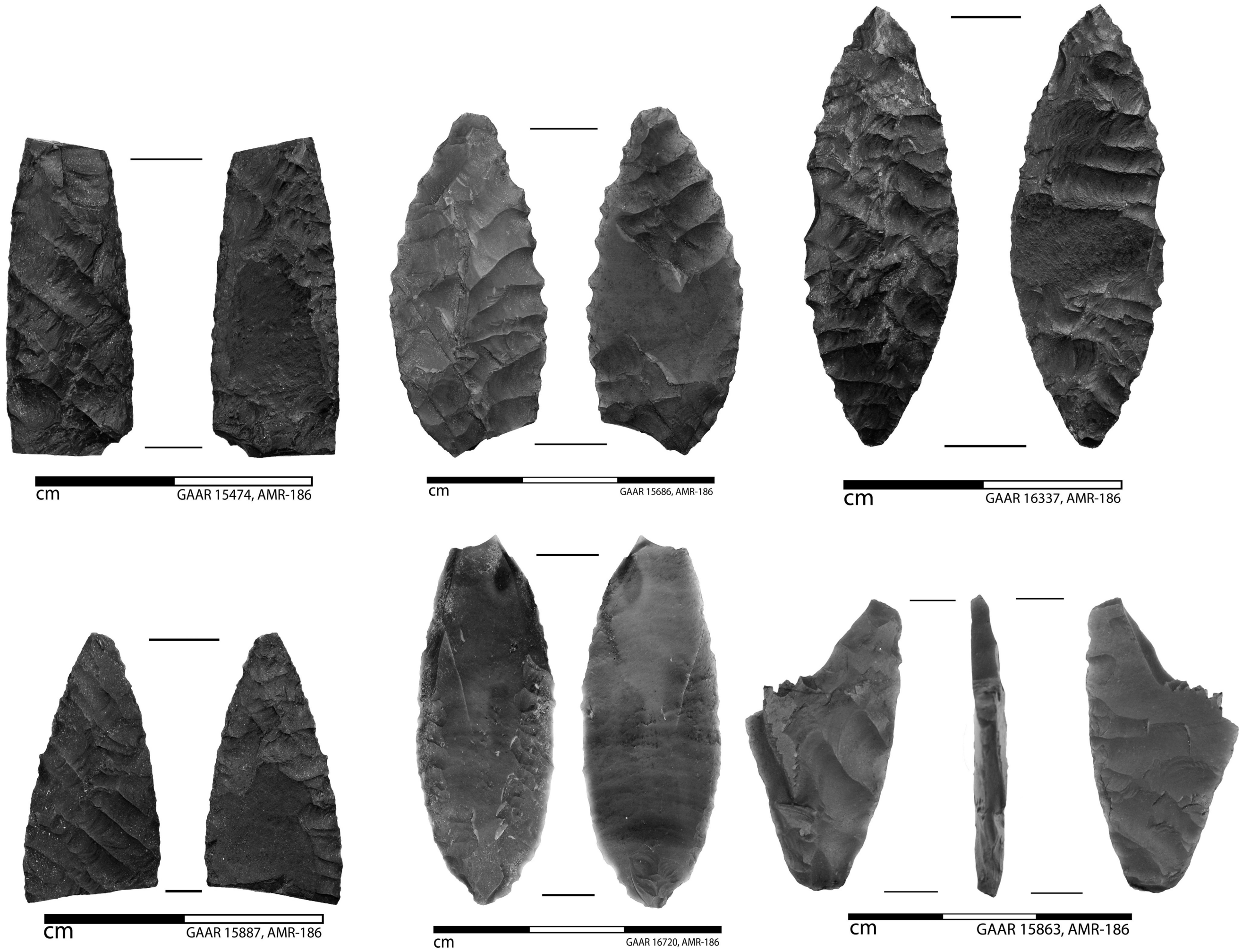

Figure 3. A sample of diagnostic Denbigh Flint complex stone tools from AMR-186. Top row, left to right: point fragment, lunate knife, end blade. Bottom row, left to right: side blade, flake knife, single-faceted angle burin.

ysis is to determine what animals were utilized by the site occupants and the relative importance of each taxon to their subsistence system. To estimate the relative importance of the taxa, I calculated the number of identifiable bone fragments (NISP) and then transformed these raw data into the minimum number of elements (MNE) and the minimum number of individuals for each taxa (Lyman 1994; White 1953). The MNI tells us how many animals would have been killed in order to account for the number of elements in the sample, and provides a conservative estimate for the original population.

MNE is also used to determine minimum number of anatomic units (MAU), an index used to measure the count of specific portions of the animal recovered at the site, such as a fore limb or cranium (Binford 1978; Lyman 1994, 2008). Unlike MNI, MAU does not assume the whole animal was brought to the site, but rather only the skeletal elements or portions thereof. Combining MNI and MAU values is of interest to the study of hunting methods, butchery, and transport of favored portions of the animal. I combined specimens into axial, cranial, forelimb, and hind limb portions (Binford 1978). If the MNI does not correspond to the MAU, either the hunters engaged in selective butchery and transport, the assemblage has undergone differential preservation, or some combination of these processes created the assemblage. Evaluating which process caused the discrepancy may be difficult or impossible; however, favorable comparison of the recovered skeletal portions to their ordinal-scale density values could suggest density-mediated attrition (Binford and Bertram 1977; Lyman 1984, 1985, 1993).

While values will vary depending on how the assemblage is aggregated (Grayson 1984; Lyman 1994; see also Morrison 1997), site AMR-186 is a relatively shallow deposit with no clear strati-

Table 1. AMS Radiocarbon Dates from the Matcharak Lake Site (AMR-186).

BETA[1]	GAAR[2]	Material	Measured ^{14}C Age	$^{13}C/^{12}C$	Conventional ^{14}C Age	2−Sigma Calibration[3]
252183	16371	caribou bone collagen	3420 ± 40 B.P.	−18.6 o/oo	3520 ± 40 B.P.	1950 to 1740 cal B.C.
252182	16009	squirrel bone collagen	3380 ± 40 B.P.	−22.0 o/oo	3430 ± 40 B.P.	1880 to 1630 cal B.C.
252181	15958	caribou bone collagen	3470 ± 40 B.P.	−18.0 o/oo	3580 ± 40 B.P.	2030 to 1870 cal B.C., 1840 to 1820 cal B.C., 1790 to 1780 cal B.C.
252180	15365	caribou bone collagen	3610 ± 40 B.P.	−20.7 o/oo	3680 ± 40 B.P.	2190 to 2170 cal B.C., 2150 to 1950 cal B.C.
252179	16537	charred *Salix*	4010 ± 40 B.P.	−24.2 o/oo	4020 ± 40 B.P.	2630 to 2470 cal B.C.
252178	16317	charred *Salix*	3480 ± 40 B.P.	−24.8 o/oo	3480 ± 40 B.P.	1900 to 1690 cal B.C.
252177	16112	charred *Betula*	3580 ± 40 B.P.	−24.7 o/oo	3580 ± 40 B.P.	2030 to 1870 cal B.C., 1840 to 1820 cal B.C., 1790 to 1780 cal B.C.
252176	15783	charred *Salix*	3530 ± 40 B.P.	−26.3 o/oo	3510 ± 40 B.P.	1940 to 1740 cal B.C.
252175	15548	charred *Salix*	3440 ± 40 B.P.	−25.2 o/oo	3440 ± 40 B.P.	1880 to 1650 cal B.C.
246518	15482	caribou bone collagen	NA	−18.3 o/oo	3590 ± 40 BP	2030 to 1880 cal B.C.

[1]Beta Analytic laboratory number
[2]Gates of the Arctic National Park catalog number
[3]INTCAL 04

graphic breaks indicating multiple occupations; therefore all specimens have been combined for this analysis. Whether or not the deposit is a palimpsest has yet to be fully addressed, though the radiocarbon dates would suggest this is the case. However, we are certain the remains represent a single component, that of the Denbigh Flint complex.

Results

The faunal assemblage from the Matcharak Lake site consists of 81,603 specimens, the majority of which are unidentified fragments (Table 2). Excavation Block A provided the bulk of the sample with 72,806 specimens, 99.5 percent of which are mammal, with bird and fish comprising .5 percent of the collection. Excavation Block B yielded 7,489 mammal specimens and 4 bird bones. The slope units and the eroded scree slope contained 1,404 mammal specimens, two bird and one fish specimen. In total 81,196 (99.5 percent) of the specimens were identified as mammal, 81 (.1 percent) as bird, and 326 (.4 percent) as fish (Table 2); of these 2,105 specimens were identified to the level of genus or species. Basic counts of NISP and MNI are provided for all species (Table 3). Species diversity (Grayson 1984) at this site is represented by four fish, two birds, and nine mammals (Fig. 7). Each animal is discussed in turn, followed by a more detailed discussion of the caribou bones, which constitute the bulk of the assemblage.

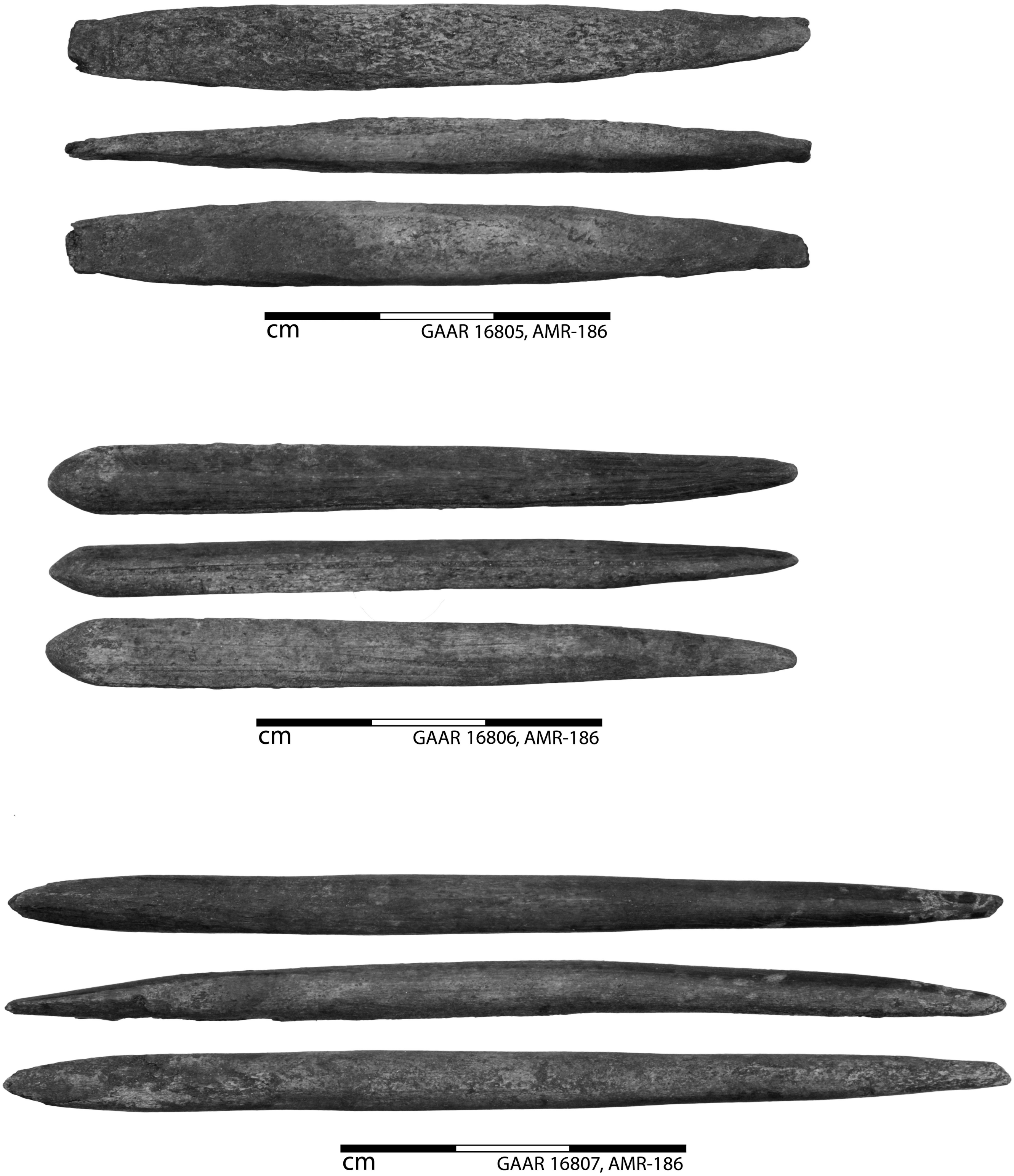

Figure 4. Bone and antler points from Matcharak Lake (AMR-186).

Figure 5. Decorated bone tool from (AMR-186).

Figure 6. Evidence of human induced bone fragmentation on a caribou metatarsal (above) and tibia (below).

Fish Remains

The Matcharak Lake assemblage contains 326 bone and scale specimens identified as fish. Of the fish bones 178 (54 percent) could be identified to species. Arctic grayling (*Thymallus arcticus*) is most abundant at 52.2 percent, burbot (*Lota lota*) second at 45.5 percent, northern pike (*Esox lucius*) represents 1.7 percent of the sample, and lake trout (*Salvelinus namaycush*) makes up only .6 percent of the fish remains (Table 3). Although Arctic grayling dominates the fish assemblage, with an NISP of 93 specimens, most of these are scales. Arctic grayling scales are distinctive and easy to differentiate from the other species while burbot, northern pike, and lake trout scales are quite similar to one another. Lake trout scales may be so small as to often pass through 1/8" screen limit-

Table 2. Number of Identified Specimens (NISP) for each Animal Class by Excavation Area.

	Block A		Block B		Slope		Total Site	
	n	**%**	***n***	**%**	***n***	**%**	***N***	**%**
Mammal	72,407	99.5%	7,489	99.9%	1,404	99.8%	81,196	99.5%
Bird	75	.1%	4	.1%	2	.1%	81	.1%
Fish	324	.4%	0	0	1	.1%	326	.4%
Total	**72,806**	**100%**	**7,493**	**100%**	**1,407**	**100%**	**81,603**	**100%**

Table 3. Vertebrate Remains from Matcharak Lake.

Bony Fishes		**NISP**	**%**	**MNI**	**%**
Thymallus arcticus	Arctic grayling	93	52.2	1	20.0
Lota lota	burbot	81	45.5	2	40.0
Salvelinus namaycush	lake trout	1	.6	1	20.0
Esox lucius	northern pike	3	1.7	1	20.0
Total identified fishes		178	100.0	5	100.0
	unidentified fish	148			
Total Fishes		**326**			
Birds					
Lagopus sp.	rock or willow ptarmigan	46	92.0	5	83.3
Anatidae	duck	4	8.0	1	16.7
Total identified bird		50	100.0	6	100.0
	unidentified bird	31	4.9		
Total Birds		**81**			
Mammals					
Rangifer tarandus	caribou	1,699	90.5	25	69.4
Ovis dalli	Dall's sheep	84	4.5	3	8.3
Canis sp.	wolf or dog	4	.2	1	2.8
Spermophilus parryii	Arctic ground squirrel	68	3.6	4	11.1
Marmota broweri	Alaska marmot	12	.6	1	2.8
Erethizon dorsatum	porcupine	2	.1	1	2.8
Lepus americanus	snowshoe hare	4	.2	2	5.6
Mustela erminea	ermine	1	.1	1	2.8
Cricetidae	lemming or vole	3	.2	1	2.8
Total identified mammal		1,877	100.0	36	100.0
Total Vertebrates		**81,603**			

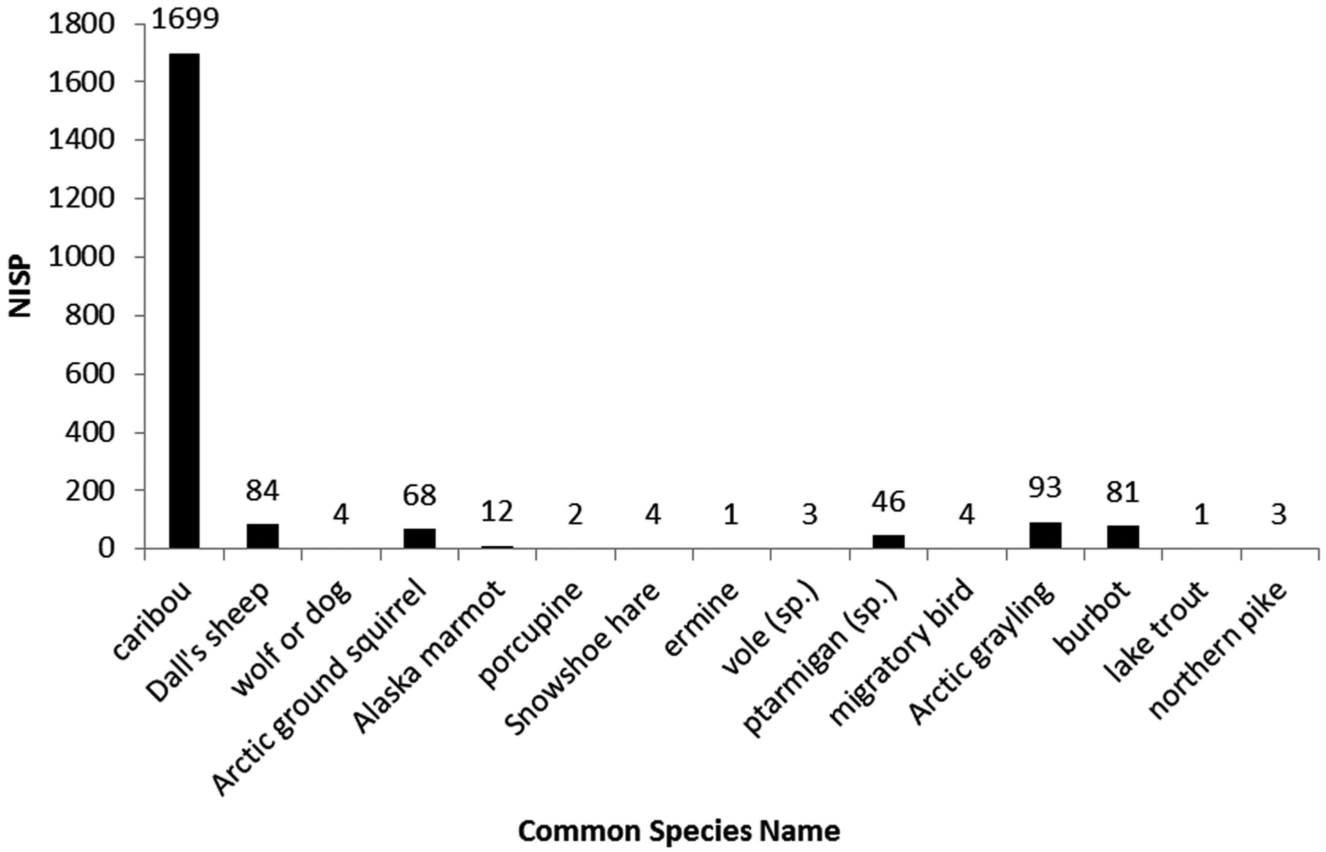

Figure 7. Number of Identified Specimens (NISP) identified to the level of genus or species.

ing their chance of recovery (Dan Odess, personal communication 2011). The high number of scales, evenly distributed throughout the excavation, could have feasibly come from one fish, though this seems unlikely. As for bone elements, burbot is represented by 81 specimens. At minimum, two burbot were brought to this camp based on two identical cranial elements recovered.

Burbot are currently found in large numbers in the lower Noatak River, but their relative frequency is unknown for the upper Noatak. Burbot are a bottom-feeding freshwater cod that, according to ethnographic sources, were traditionally caught by jigging (Betts and Friesen 2004); modern fishermen bait a hook and send the line to the bottom of the river. Historically burbot were targeted in winter (Betts and Friesen 2004). The presence of a bottom feeding fish implies Denbigh people had a sophisticated hook and line system to catch them. Arctic grayling, on the other hand, are abundant and easy to catch or spear in sloughs and feeder streams.

Lake trout are represented by one cranial element and northern pike by three. Both lake trout and northern pike are today found in Matcharak Lake, and my experience catching these fish suggest with the right equipment they could be lured close enough to shore to be speared. At minimum, five individual fish were consumed at the Matcharak Lake site. This MNI value is likely an underestimation. Many fish bones are so small that even a 1/8 inch mesh is too large to capture them (Grayson 1984:168–172). However, relative to other taxa and given the level of preservation, fish likely accounted for a few meals at Matcharak Lake.

Bird Remains

Birds are represented in even lower numbers than the fish. A limited number of migratory and year round bird species should have been available to the site occupants for any given season. Of the 81 bird specimens identified, 46 (57 percent) could be assigned to genus, and 4 (5 percent) to family level (Table 3). The Matcharak Lake assemblage yielded 46 willow or rock ptarmigan (*Lagopus* sp.) specimens that represent at least five individuals, based on proximal humeri. Willow ptarmigan are known to live in the Brooks Range year round except during their annual migration north in spring (Irving et al. 1968). Historically, willow ptarmigan were a food source to inland Iñupiaq in times of caribou shortage (Gubser 1965; Irving et al. 1968). The remaining identified bird bones are four specimens, a tibia and three phalanges that most closely resemble members of the Anatidae family, likely a species of duck as they are considerably smaller than goose or swan. The presence of migratory bird bones holds implications for the season of site occupation, which is discussed in greater detail below.

Mammal Remains

Mammals, at 99.5 percent of the recovered fauna, overwhelmingly dominate the Matcharak Lake faunal assemblage (Table 3). Of the identified fragments, 90.5 percent are caribou while eight taxa comprise the other 9.5 percent of the identified mammal specimens.

Non-caribou specimens include three tiny rodent bones, likely from a species of lemming or vole. These small rodent bones make up less than .2 percent of the animals represented and may be commensals rather than a species captured for consumption by past occupants. One ermine (*Mustela ermina*) mandible was recovered, making up .1 percent of the identified sample. Ethnographic use of ermine by native inhabitants of the area suggests ermine fur was used mainly for clothing decoration, not as a food source (Gubser 1965). Four snowshoe hare (*Lepus americanus*) specimens were identified, making up .2 percent of the mammal NISP. Of these four bones, two are different-sized scapulae indicating at least two snowshoe hares were killed and processed. Snowshoe hare numbers are known to fluctuate drastically through periodic cycles (Krebs et al. 2001), which would have governed the availability of this resource to past hunters.

Another small mammal identified in the Matcharak Lake assemblage is porcupine (*Erethizon dorsatum*) represented by one incisor and one tibia shaft. The two elements constitute only .1 percent of the identified mammal specimens. If porcupine bones represent dietary remains, they clearly formed a minor part of the diet, though it does suggest occasional exploitation of this resource.

Alaska marmots (*Marmota broweri*) yielded an NISP of 12 (.6 percent) and an MNI of one. Like Arctic ground squirrels, discussed below, Alaska marmots are a hibernating species, spending nearly nine months of the year underground (Nowak 1991). Thus, the season of death was likely summer. Since their habitat is rocky scree slopes, marmot were most certainly hunted and brought to the site by humans. Arctic ground squirrels (*Spermophilus parryii*) are much more common in the Matcharak assemblage than the Alaska marmots with an NISP of 68 (3.6%) and an MNI of four. While Arctic ground squirrels were likely to have been consumed by the occupants; there is an active Arctic ground squirrel colony living at this site today. A number of burrows tunneled into the slope and eyewitness sightings of the animals suggest some of the bones may be the result of natural deaths. The fact that most of these bones are mixed throughout the assemblage, however, coupled with weathering that is consistent with the other specimens, suggests at least some were meals of the Denbigh people. Ethnographic data show Iñupiaq Eskimos utilized ground squirrel as fur-bearers as well (Burch 2006:25). A large colony of ground squirrels might influence a group's decision to place a camp at a given location (Odess 2003).

Four bones of the genus *Canis* were identified; three vertebrae fragments and one tibia-shaft fragment. These *Canis* bones make up .2 percent of the total mammal NISP for mammals and with an MNI of one were a limited resource at this site. If these bones are wolf, they were likely taken as a fur bearing animal to provide ruffs on parkas or for some other purpose (Burch 2006:4). It is equally possible that these bones represent the remains of a domestic dog. While evidence for domesticated dogs extends much further back in time than 4,000 years (e.g., Savolainen et al. 2002), no sites in Alaska have yet to provide clear evidence for dogs in early ASTt, and thus we are uncertain if dogs were a part of Denbigh culture. Although dogs have been identified infrequently in ASTt sites in Canada and Greenland (see Morey 2010; Morey and Aaris-Sorensen 2002), their presence in the oldest Saqqaq sites in West Greenland (Grønnow 1994; Meldgaard 2004; see also Gotfredsen 1998; Møhl 1986) suggests that we should expect to find ASTt dogs in Alaska as well. Currently the *Canis* bones from Matcharak Lake are undergoing genetic analysis at the Veterinary Genetics ancient DNA laboratory at the University of California Davis with the goal of resolving this issue. Evidence for dog domestication would bring greater resolution to our interpretations of Denbigh mobility, camp activity areas, site taphonomy, and our general understanding of their culture.

Dall's sheep (*Ovis dalli*) is the second most common animal identified from Matcharak Lake and has an NISP value of 84, or 4.5 percent of the identified mammals, and comprises 4.2 percent of the artiodactyl remains. Ten percent of the artiodactyl bones are identified as either caribou or sheep, the other 90% were identified to species. The Dall's sheep bones represent an MNI of three based on proximal humeri. In 2008, two separate herds of Dall's sheep were spotted in the mountains 3 km west of Matcharak Lake. The presence of skull, axial, forelimb, and hind limb parts suggests the hunters transported a whole carcass to the site. No significant correlation between %MAU and bulk bone density was found for the sheep bones (rs = .178; p = .376) supporting this conclusion. Dall's sheep were unlikely to have been commonly present in the middle of the valley, thus the hunters must have travelled to the nearby mountains, killed them, and carried the carcasses back to camp.

Caribou

Caribou (*Rangifer tarandus*) is by far the dominant species identified in the Matcharak Lake assemblage. I was able to identify 1,970 (2.4 percent) of mammal specimens to order Artiodactyla. An NISP of 1,699 caribou bones account for 90.5 percent of the total identified mammal bones and 86.2 percent of the artiodactyl remains. The remains that could be identified as caribou represent at least 21 adults, four juveniles, and one fetal animal. While parts of at least 25 caribou were brought to the site, we cannot be sure that all anatomical units are represented. The problem with using MNI alone is that it assumes each caribou carcass was brought to the site in its entirety. Ethnographic evidence of the "Shlepp effect" suggests differential transport of higher utility body segments may have occurred at Matcharak Lake as well.

To better understand the nature of the Denbigh occupation at Matcharak Lake, I analyzed the MNE, MNI, and MAU values for the caribou remains (Table 4). I assume complete segments were transported together as a package. It makes little sense to transport a metatarsal from the kill site but not the femur, as the femur has a higher utility index (Binford 1978). Thirty-nine hind limbs represent the most frequent segment of caribou in the assemblage. Forelimbs are less common with 26, 16 left and 10 right segments represented. If selective transport occurred, this bias against forelimbs is shared by the Nunamiut, 3,500 years later (Binford 1978:40). Underrepresentation of forelimbs may be due to the lower forelimb utility index. When caribou are under nutritional stress the first part of the body to suffer are the forelimbs (Binford 1978:40). Assuming the mandible was brought attached to the rest of the head then Denbigh hunters selected the head almost as frequently as the hind limbs. Further evaluation of skull bones was not considered, although numerous maxilla and unidentified cranial fragments were recovered. Axial segments appear to be extremely underrepresented as the total ribs and vertebra account for only five rib cages.

Bone density values for Artiodactyls (Lyman 1985; 1994) were plotted against the percent minimal anatomical unit (%MAU) for each skeletal element or portion thereof, i.e., proximal, distal (Fig. 8). Element frequency is correlated with bulk density as indicated by Spearman's Rho rank order correlation (rs = .690; $p < .001$). The result indicates that the densest bones are found in the highest frequencies. Density-mediated attrition seems to have led to a relatively higher degree of preservation for the densest bones and increased decomposition of the least dense bones, such as axial elements. However, this also speaks to the high degree of fragmentation most likely the result of heavy processing of the skeletal elements for marrow and tool production, which tends to increase the number of unidentified mammal fragments (Lyman 1994). In this case the frequency of mammal fragments in classes 3–5 overwhelmingly dominate the assemblage and are likely the remains of heavily processed (and decomposed) caribou bone.

Further analysis of this data set involved statistical comparison of the skeletal elements represented to expected values based on a ranked order of utility based on the amount of grease, marrow/fat, and meat available for each anatomical section. Here I use the Food Utility Index (FUI) developed by Metcalfe and Jones (1988). Results show there to be no significant correlation between %MAU and the FUI (rs = .197; p = .523) suggesting bones with a higher food utility index do not occur in higher frequencies (Figure 9). The implication of this is that the whole carcass was most often transported to the site and/or that bones with a lower utility index preferentially survived destruction. A weak correlation between low bone density and high utility index has been noted; inversely, some low utility elements have a higher bulk density (Lam and Pearson 2005; Lyman 1985). The paucity of higher utility elements would suggest differential preservation due to natural deterioration or from cultural behaviors that destroyed these portions of bone. Ribs, vertebra, and long bone epiphyses are all relatively high in food utility and low in bulk density. The high grease content of these bones makes them more likely to be pulverized for grease extraction. The presence of nearly twice as many identified proximal femur elements than distal femur portions suggests some of the discrepancy is due to human activities.

Denbigh Diet at Matcharak Lake

Since one of the goals of archaeology is to understand how humans interacted and adapted to their environment, one way to tease out this information is to examine the relative importance of each species in the faunal assemblage. Animal resources are used for a variety of purposes including clothing, shelter, tool production, and food. This analysis focuses mainly on Denbigh diet. To do so, we

Table 4. Caribou Skeletal Elements Recovered from Blocks A and B at Matcharak Lake.

Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juvenile MNE	MNI	Juvenile MNI	MAU
Ribs	112		32	54		35	37		50	1	4	1	2.5
Vertebra	73				8				39	4	2	1	1.5
Cranial fragments	742												
Mandible fragments	125												
Dentary ramus/tooth row	36					15	19		33	1	18	1	17.5
Teeth	537	537							537		16	1	
Antler (unmodified)	44												
Scapula	15			4		3	4		7	1	4	1	4
Humerus	32		16	10		9	9		18		9		9
Radius	72		15	22		16	10		26		16		13
Ulna	22		7	3		3	4		7		4		3.5
Metacarpal	53	1	22	18	7	7	8	13	28	7	11	4	14
Carpals	26	22							26		3		2.17
Innominate	4					3	1		3		3		1.5
Femur	87		15	32	2	8	11	17	36	2	17	1	18
Tibia	81	1	25	19	2	15	17	0	32	2	20	2	16
Metatarsal	127	0	17	35	0	18	18	3	39		21		19.5
Calcaneus	16					8	8		16		8		8
Astragalus	17					7	9	1	17		9		8.5
Tarsals	16	12							16		2		1.33
Metapodial	54		19	10					9		3		4.5
Phalanges	60	43	13	6					64		9		5.3

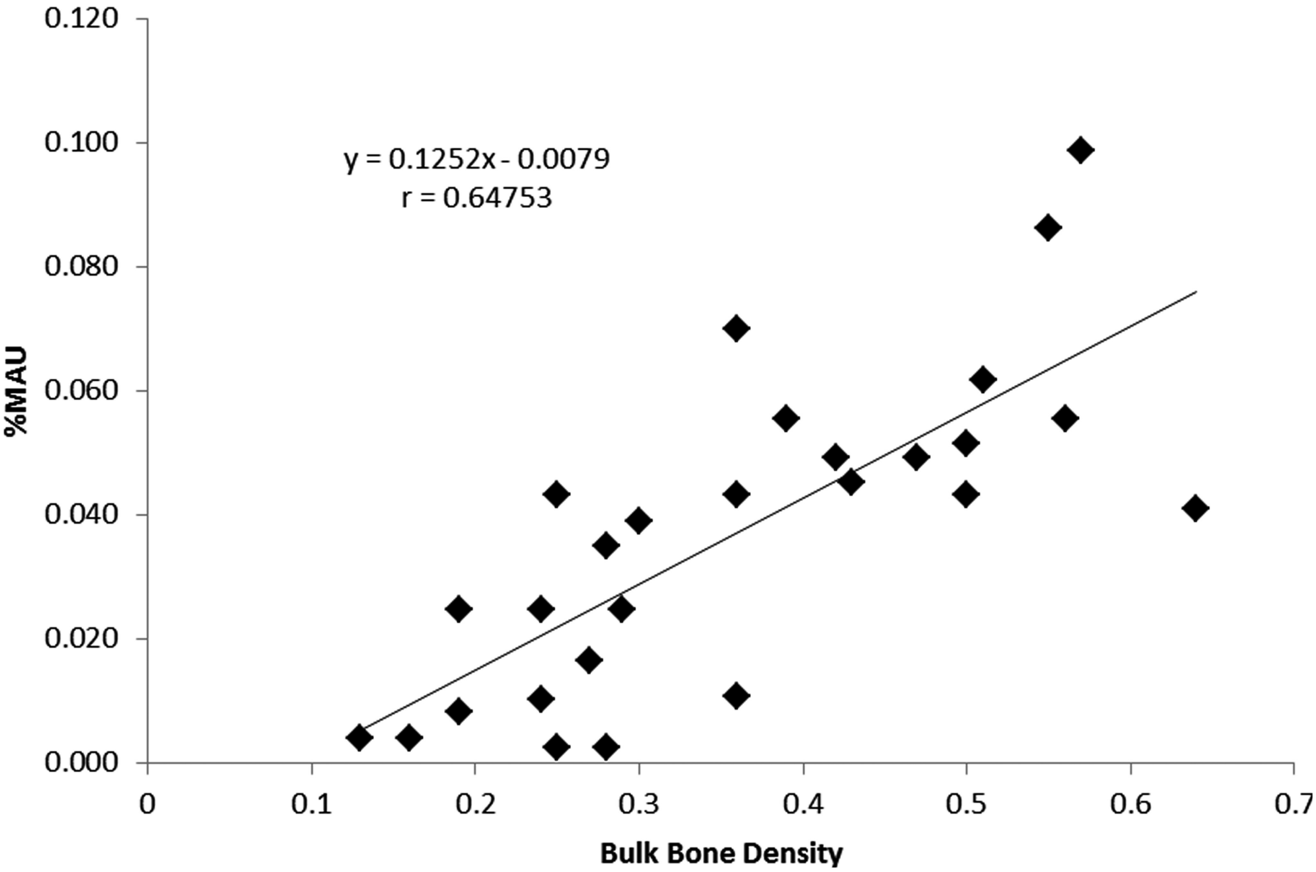

Figure 8. Bivariate scatterplot of bone density values (Lyman 1984) versus %MAU.

first need to consider how many calories are available from an average-sized animal from each taxon identified (Table 5). Using published data, I multiplied the average weight of adult animals and the percent of edible portions of each by the estimated kilocalories per kilogram of meat to derive the total number of calories available for a given individual from each species (Table 5) (Byers and Ugan 2005; Nowak 1991; USDA 2010). Caloric values and amount of meat vary between sex and age classes, but the presence of both large males and juveniles should produce a mean value that closely resembles the population. Finer resolution with the caribou would not produce significantly different results as compared to the other species. I also present the total number of kilocalories represented by the sample and how many person days of food are represented, assuming a 2,000 calorie per day diet (Table 6). Population values are arbitrarily provided, though they are based on ethnographically documented average band sizes for highly mobile hunter-gather populations (Burch 2006; Kelly 2007). If the Denbigh bands were larger then, of course, less time would be represented.

Calculated results from Matcharak Lake show that caribou dominate not only in terms of specimens represented (NISP) and MNI, but also in terms of calories (Table 7). A total of 50 animals were killed and at least parts of each were brought to the site and consumed. Although caribou make up only 53.2 percent of all individual animals, they account for 93.6 percent of potential calories consumed. Dall's sheep, with three individuals represented, likely provided 4.9 percent of the caloric intake (Table 7). Thus, based on this sample, 98.5 percent of all the kilocalories acquired at Matcharak Lake were derived from artiodactyl consumption. Small mammals combined to provide only one percent of the total calories, while .5 percent of the calories were likely derived from fish and birds. Approximately 53 days of food would have been available to a group of 25 if they consumed 2,000 calories a day or less. Considering this assemblage is estimated to be only a 10 percent sample of the site, it would appear the occupants could have spent some time here; whether this is a result of multiple visits or a one-time occupation is unclear.

Since there is such a strong emphasis on caribou meat, and secondarily on Dall's sheep—why then are the other species represented at all? To understand this we need to consider the seasonal

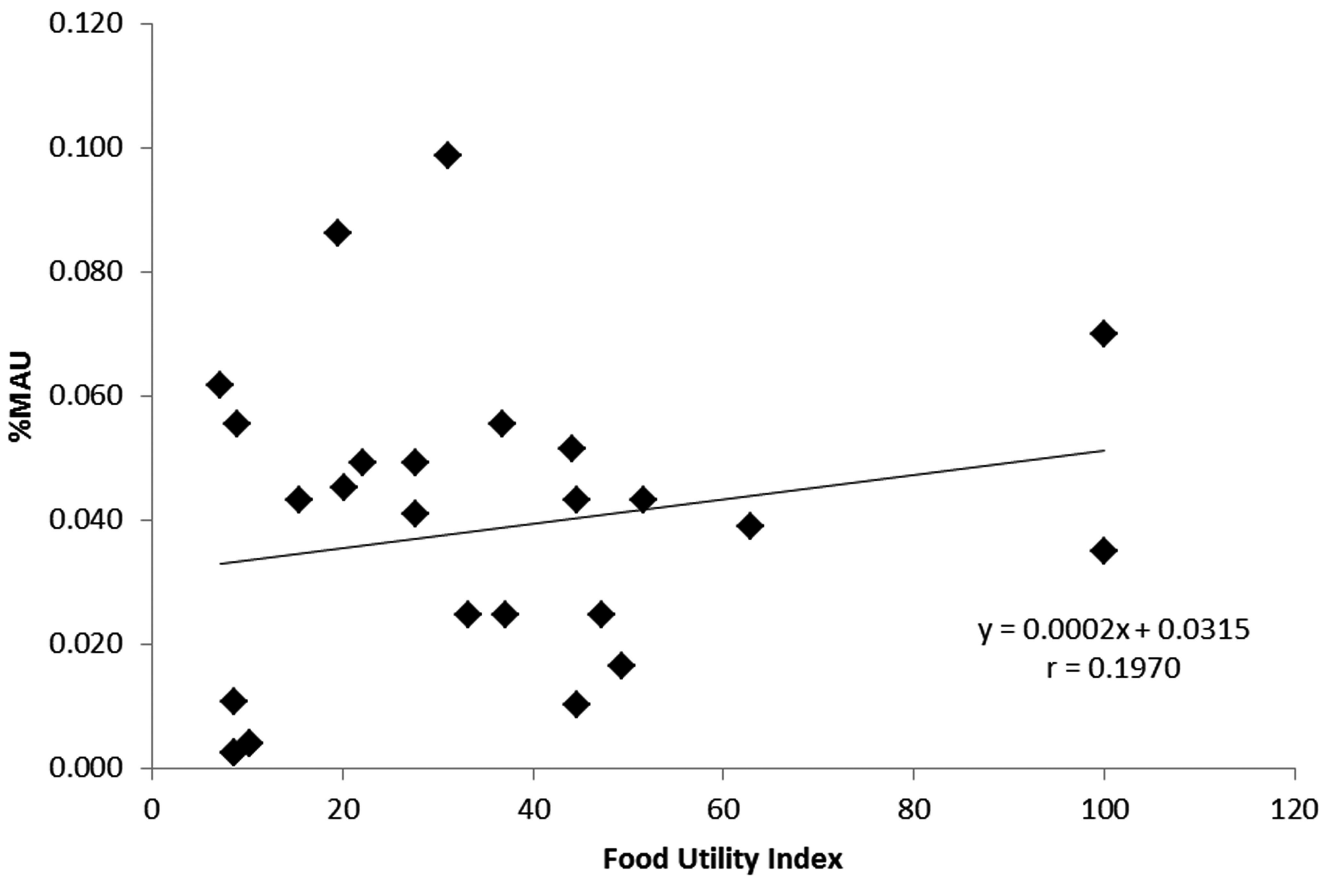

Figure 9. Bivariate scatterplot of Food Utility Index values (Metcalfe and Jones 1988) versus %MAU.

fluctuation of caribou into the upper Noatak Valley. Caribou of the Western Arctic herd migrate en masse from their wintering grounds in the Kobuk River valley to the south, north through the valleys of the Brooks Range to their calving grounds on the North Slope (Harper 2006). This migration event occurs April through June. Caribou occur in very low frequencies around the Matcharak Lake area in the summer, but begin their fall migration again in early to mid-August through October. They are nearly absent again throughout the winter (discounting the occasional small herd or lost individuals) (Harper 2006). The fluctuation of caribou population density dictates what animals will be taken. When a large herd of caribou is present near camp, all energy will likely go towards pursuing this prey rather than hiking further afield to take a Dall's sheep or to search out other small mammals. Only when caribou are absent does it make sense to expend that extra time and energy to hunt sheep. This would produce seasonal fluctuations in diet-breadth mitigated by the presence or absence of caribou.

The role of women, children, or elderly members of the group is not well understood but some may have spent time trapping, fishing, hunting birds, and preparing hides while others pursued larger game. A more parsimonious explanation is that diet breadth broadens when caribou are absent or at low population densities in the resource patch, leading to the exploitation of the lower ranked prey represented at Matcharak Lake. While beyond the scope of this study, I acknowledge one would have to consider search and handling costs and the population densities for each mammal, bird, and fish to accurately predict the rank of each species (e.g., Bettinger 1991; Kelly 2007) but the overwhelming availability of calories provided by a massive herd of caribou will certainly swamp the combined calories of all the small animals in the patch combined. Thus diet breadth should be a function of seasonal availability of caribou. Can we infer seasonal activities occurred based on these observations? Can we observe these activities archaeologically?

Season of Site Occupation

In this section I present seasonality data for Matcharak Lake to better understand the occupational history of the site. Of the 14 species recorded in the Matcharak Lake faunal assemblage,

Table 5. Average Weight and Caloric Values for Identified Prey from Matcharak Lake.

Resource	Energy[1] (Kcal/kg)	Live Weight (kg/ind.)	Edible Fraction	Edible Weight (kg/ind.)	Total Kcal
Caribou	1,270	131.0	.60	78.60	99,822
Dall's sheep*	1,270	90.0	.60	54.00	68,580
Alaska marmot*	1,200	9.0	.70	6.30	7,560
Porcupine*	1,140	12.0	.70	8.40	9,576
Northern pike	1,130	2.0	.70	1.40	1,582
Burbot	1,090	2.0	.70	1.40	1,526
Ptarmigan	1,340	1.5	.70	1.05	1,407
Snowshoe hare*	1,140	2.0	.60	1.20	1,368
Grayling, trout	1,480	1.0	.70	.70	1,036
Arctic ground squirrel*	1,200	1.0	.85	.85	1,020
Migratory duck	1,230	1.0	.70	.70	861

[1]Byers and Ugan 2005; USDA 2009; * Estimated from related taxon.

Table 6. Total NISP and MNI for Species at Matcharak Lake.

Animal	NISP	MNI	Edible Weight Kg/ind.	Total Kcal	Available Kcal	per/ person 2000 kcal/day	per/10 persons 2000 kcal/day	per/25 persons 2000 kcal/day
Caribou	1,699	25	78.60	99,822	2,495,550	1247.78	124.78	49.91
Dall's sheep	84	3	36.00	43,200	129,600	64.80	6.48	2.59
Arctic ground squirrel	68	4	.85	1,020	4,080	2.04	.20	.08
Alaska marmot	12	1	7.65	9,180	9,180	4.59	.46	.18
Porcupine	2	1	9.35	10,659	10,659	5.33	.53	.21
Snowshoe hare	4	2	1.20	1,368	2,736	1.37	.14	.05
Birds	81	6	1.05	1,407	8,442	4.22	.42	.17
Fish	326	5	1.40	1,526	7,630	3.82	.38	.15
Wolf	4	1	n/a	n/a	n/a	n/a	n/a	n/a
Ermine	1	1	n/a	n/a	n/a	n/a	n/a	n/a
Lemming/ vole	3	1	n/a	n/a	n/a	n/a	n/a	n/a
Total	2,284	50		168,182	266,7877	1333.94	133.39	53.36

Table 7. Estimated Relative Dietary Contribution.

Resource	Percent of Diet
Caribou	93.59
Dall's sheep	4.86
Porcupine	.40
Alaska marmot	.34
Ptarmigan	.26
Arctic ground squirrel	.15
Burbot	.11
Snowshoe hare	.10
Grayling, trout	.08
Northern pike	.06
Migratory duck	.03

only four are useful as seasonal indicators: caribou, migratory birds, Arctic ground squirrel, and Alaska marmot. The remaining taxa are currently available year round in the Noatak Valley. At least one occupation occurred during a major caribou migration, either in spring or fall. A fetal caribou scapula and metapodial were identified, documenting that a pregnant female caribou was killed. Fetal caribou bones place Denbigh people at Matcharak Lake in April or early May (Harper 2006). Further evidence for spring caribou hunting is derived from three skull fragments with shed antler cores. Male caribou shed antlers after rut, while females shed in late winter (Burch 1972). Antlers do not begin to grow back until summer. These caribou were killed in either winter or spring. Few caribou exist in the upper Noatak in winter, thus these caribou were most likely taken during the spring migration. A final spring indicator is a caribou mandible with a tooth eruption pattern similar to an 11–13 month old (Miller 1974).

Another caribou mandible was aged to approximately three months of age using tooth eruption patterns (Miller 1974). This caribou would have been killed in late summer or early fall, mid-August to early October. A number of elements exhibit unfused epiphyses indicating juvenile caribou were procured, but the diminutive size of one complete tibia (and comparison to reference skeletal collections) suggests this individual was approximately three to four months old. Finally, a cranial fragment with antler attached was recovered from excavation Block B, suggesting this animal was deposited in the fall. While antlers can be collected at any time of year, it makes little sense to transport the antler back with a skull still attached. While admittedly a limited sample, these three elements indicate that the death of these animals and the likely human occupation of the site, occurred in fall.

Evidence for summer occupation comes from the migratory bird species. Four specimens were identified as Anatidae, which is a family of duck. These birds are present at Matcharak Lake from May to September and could have been killed at any time during those months. Their migration also overlaps with both the spring and fall caribou migrations. Consumption of Alaska marmot and Arctic ground squirrel likely occurred in summer as these animals are above ground for only three months of the year (Nowak 1991). Migratory bird, squirrel, and marmot bones suggest a warm weather occupation, late spring, summer, or early fall.

In combination, the seasonality markers indicate people were present at Matcharak Lake in the spring, hunting northward migrating caribou; in summer subsisting off migratory birds and small mammals, Dall's sheep, and fish; and in fall, when the caribou were migrating south to their winter grounds. Solid evidence for a winter occupation is lacking, but ethnographic data from Nunamiut and other Inuit groups show Dall sheep, ptarmigan, and burbot were common winter staples (Betts and Friesen 2004; Burch 2006; Gubser 1965; Irving et al. 1968). If the Denbigh were at Matcharak Lake in the winter they did not use semi-subterranean sod houses as described from Onion Portage (Anderson 1988). Instead the only evidence for house type comes from a potential tent ring represented by four manuport boulders. Further excavation is required to determine if a feature is indeed present.

Conclusions

This data set provides valuable new insights into the culture of the Denbigh Flint complex by broadening the known distribution of Denbigh sites in the Brooks Range and by producing a number of exceedingly rare organic tools. One decorated bone tool documents empirical evidence that Denbigh social life included artistic activities, as Giddings (1956) suggested it must. Most important, however, is the massive faunal assemblage and the implications the bones hold for understanding Denbigh subsistence and technology.

The Denbigh subsistence strategy for the upper Noatak was organized around migrating caribou herds, with the bulk of the diet derived from caribou. Denbigh people camping at Matcharak Lake did exploit other animals, presumably during seasons when caribou herds were rare in this region. In general, hunter-gatherers with narrow diet breadths will exploit lower ranked prey when preferred taxa are absent (Broughton 1994). Denbigh behavior was clearly linked to ecological and environmental constraints of the Arctic resource structure. In general, Denbigh people possessed a highly developed and sophisticated understanding of the animal cycles, behavior, habitat, and the seasonal availability of prey in the Brooks Range. This knowledge led them to place their camp at Matcharak Lake where they procured at least 25 caribou, and likely a great many more as only about 10 percent of the site has been excavated. This group hunted male caribou, juveniles, and pregnant females. Seasonality data from Matcharak Lake suggests the group was present in spring, late summer, and/or early fall. They set up skin tents, as represented by a partially excavated tent ring, and then hunted caribou. A few summer species, such as Dall's sheep, Arctic ground squirrel, Alaska marmot, and migratory birds were killed, perhaps as the hunters awaited arrival of the caribou.

Future work will focus on differential seasonal processing of caribou and on aging caribou teeth through dental thin sectioning to gain a better understanding of site seasonality and prey mortality. Future studies should also consider what kinds of caribou skins are most desirable for clothing, and shelter, as this too might help explain the sex and age of caribou being hunted. Other studies should consider ASTt tool kit variation as related to the presence of the selected prey. Denbigh hunters living at Matcharak Lake were specialized towards seasonally available caribou, as many researchers have predicted, but they also utilized, at one time or another, most of the species that live in the area. This localized subsistence data sheds light on interior hunting activities and will support efforts to refine regional Denbigh subsistence models, but more work is necessary to accomplish this goal. Discovery and analysis of sites such as Matcharak Lake cross-cutting the spatial and temporal boundaries of Paleoeskimo culture are necessary to fully understand the processes of initial colonization Arctic Canada and Greenland.

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